UNIVERSITETI I EVROPËS JUGLINDORE
УНИВЕРЗИТЕТ НА ЈУГОИСТОЧНА ЕВРОПА
SOUTH EAST EUROPEAN UNIVERSITY

Study program	Computer Sciences
Faculty	Contemporary Sciences and Technologies
Study Cycle	Second Cycle (Postgraduate)
ECTS	120
Code	CS-120
Title	Master in Computer Sciences - Module: Computer Sciences
Accreditation archive number [120]	03-2079/8
Accreditation archive number []	
Decision for starting of the program	
Accreditation date	01.12.2022

Description of the program

Changes in the field of computer sciences and their application are very dynamic. The main challenge of the research and studies in this area is developing new advanced systems and technologies that will provide solutions in the area of information and communication technologies. Information and communication technologies have become the largest, the most important and the most developed sectors that are rapidly expanding in the European Union and the global market. In addition, the emergence of new markets for the software and telecommunications sector in Southeast Europe has led to increased demand for highly qualified and specialized professionals in this field. Graduate students can work as professional software engineers or as software architects in the development of software companies or in IT departments of various different enterprises. The high level of professional skills will enable graduate students to become successful leaders in the software industry.

Career

The program will supply students with the necessary knowledge and skills so that they can contribute in all aspects of the software development process, including planning, collaboration, specifications, design, development, delivery and maintenance of software products. In addition, students will also acquire general skills, such as analytical and critical thinking, teamwork including multicultural environments, planning and organization. After finishing this program, the graduates will have career opportunities in a variety of industries, mainly fulfilling the needs for designing computer systems, developing software for mobile and Web applications, working as database engineers, managers of software projects and processes, etc. depending on the track the students will choose within this study program. The last semester of studies includes master thesis writing, enabling program graduates to continue their studies towards a doctoral degree in computer sciences.

Learning outcomes

Knowledge and understanding

- Ability to develop and implement original and creative IT ideas to ensure the quality and design and managing applications related to telecommunications applications areas such as security and quality assurance;
- Ability to apply IT skills and knowledge and demonstrate specialized competencies in computer sciences and information technologies in order to organize and connect telecommunications processes like a structure that is managed and monitored both in terms of data flow and in terms of creating user interfaces;
- Having knowledge and understanding of areas such as computer sciences and engineering (programming, web technologies, databases, networks, computer and information systems and multimedia);
- Having knowledge of one or more areas of the telecommunications industry that can upgrade students to expert s in the application of knowledge in a given area;

Applying knowledge and understanding

- Ability to critically, independently and creatively solve problems in new and unfamiliar environments with no previous experience in telecommunications;
- Planning, management and evaluation of independent research in the field of telecommunications as well as development and implementation of appropriate tools for testing, simulation and implementation;
- Creativity and originality in the interpretation of the knowledge in informatics to solve problems related to the objectives of the industrial production area of telecommunications;

Making judgement

- Ability for creative integration and synthesis of knowledge from several areas in the telecommunicationsfield, and administration processes and systems using IT tools designed and created for a specific issue.
- Creating educational processes using computer tools and techniques;
- Ability to deal with complex situations associated with specific processes resulting in real-time telecoms space;
- Ability to identify appropriate specialized instances and make sound judgments in situations of lack of complete information or data based on personal, social and ethical principles and responsibilities associated with the application of knowledge and understanding;

Communication skills

- Ability to share findings and proposals with rational argument and reliance both with professionals and with unskilled people, clearly and unambiguously;
- Taking considerable responsibility in shared outcomes, running, and initiating activities, etc.

Learning skills

- Able to identify personal needs and directions for individual and autonomous study and to perform it in self-directed and autonomous manner in the common business and informatics areas.
- Able to take responsibility for ongoing individual and group learning in specialized business and informatics fields within the networked economy, including defining learning objectives for medium and longer terms.

List of courses

Semester 1

- [CM201] [6.0 ECTS] **Distributed Systems**
- [CM202] [6.0 ECTS] **Logical and Functional Programming**
- [CM203] [6.0 ECTS] **Computer Graphics**
- [6.0 ECTS] **General Elective Course**
- [6.0 ECTS] **Professional Elective Course**

Semester 2

- [CM194] [6.0 ECTS] **Practicum**
- [CM205] [6.0 ECTS] **Cloud Infrastructure and Technologies**
- [CM204] [6.0 ECTS] **Computer Security**
- [6.0 ECTS] **General Elective Course**
- [6.0 ECTS] **Professional Elective Course**

Semester 3

- [MCS-303] [6.0 ECTS] **Research Methodology**
- [CM191] [6.0 ECTS] **Advanced Algorithms and Data Structures**
- [CM192] [6.0 ECTS] **Formal Methods in Computer Science**
- [6.0 ECTS] **Professional Elective Course**
- [6.0 ECTS] **Professional Elective Course**

Semester 4

- [CST-THESIS-120] [30.0 ECTS] **Master Thesis**

Description of courses

Core courses

- **Distributed Systems**
  Distributed systems have become widely inescapable and are having a tremendous impact on various domains of human activity. They range from ad-hoc networks comprising of tiny sensor devices, to massive web farms of powerful servers. Therefore, this course will cover current topics in modern distributed systems such as client-server models, inter-process communication and network protocols for communication, middleware, services, clock synchronization, distributed transactions, security, and cloud computing. Case studies on real distributed systems will be conducted, and recent research literature in the subject area will be reviewed.

- **Logical and Functional Programming**
  This course aims to introduce students to the basic concepts of logical and functional programming paradigms. Within logical programming, students will be introduced to the concepts of predicate logic and declarative programming through the Prolog programming language. Within functional programming, students will be introduced to the concepts of lambda calculus, abstract data types, induction and recursion, and specific data structures such as lists and infinite trees. The course will also include an overview of the usage of functional programming style in modern imperative programming languages.

- **Computer Graphics**
  The main objective of this module is to introduce to the students the concepts of computer graphics. It starts with an overview of interactive computer graphics, two-dimensional system and mapping, then it presents the most important drawing algorithm, affine transformation, anti-aliasing, textures, and linear algebra.

- **Practicum**
  On successful completion of this course, students should be able to relate academic course material to real teaching conditions at workplace; develop experience in various aspects of teaching ICT such as planning, organizing, material selection and lesson delivery, as well as adapting to workplace culture; develop appropriate work related habits and professional attitudes by observations of skilled teachers; communicate effectively in a variety of forms to students, parents and colleagues; and work in a team.

- **Cloud Infrastructure and Technologies**
  This course introduces to students the foundational knowledge required for understanding cloud computing from different perspectives, both technological and the business one. Students will learn about the various cloud service models (IaaS, PaaS, SaaS), deployment models (Public, Private, Hybrid) and the key components of a cloud infrastructure (VMs, Networking, Storage - File, Block, Object, CDN). The course also covers emergent cloud trends and practices including - Hybrid Multicloud, Microservices, Serverless, DevOps, Cloud Native and so on. Finally, some other important topics such as cloud security, monitoring, and different job roles in the cloud industry are explained.

- **Computer Security**
  This course teaches principles of computer security from an applied viewpoint and provides hands-on experience with security threats and countermeasures. The course additionally covers principles and skills useful for making informed security decisions and for understanding how security interacts with the world around it. Applied topics include cryptography, authorization control, operating systems security, and web and network security. Other topics

include general security principles, human factors such as trust and social engineering, the security of complex systems, and the economics of security. The course aims to balance theory and practice.

- **Research Methodology**
  The purpose of this course is to provide students with knowledge and understanding of different scientific theories and methodologies. Initially the student will be introduced to the conceptual, theoretical definitions and examples of all existing methods of research, hypothesis, direct and indirect variables, validation of the results, the conclusions BIAS and scientific qualitative and quantitative methodologies, "ground research" methodology and other methodological approaches. In each chapter the student will work on practical assignments. After completing the course the student will be able to explain thoroughly and understand the importance of basic scientific concepts, effectively search and find information-relevant literature, identify, describe and formulate scientific problems, make a careful choice of alternative research approaches, thoroughly described, compare and explain the advantages and disadvantages of different scientific methods for collecting quantitative and qualitative data, apply basic scientific methods to analyse quantitative and qualitative data, understand different frameworks for building theory and review and evaluate scientific publications.

- **Advanced Algorithms and Data Structures**
  This course builds on previous knowledge in the area of algorithms and data structures. The goal of the course is to acquaint students with efficient advanced algorithms and adequate data structures that are used to organize, search, and optimize data. It also includes the theoretical efficiency of algorithms and its practical determination in order to be able to compare different algorithms. During the course, students will be introduced to several well-known algorithms, particularly search and optimization in complex nonlinear structures such as trees and graphs.

- **Formal Methods in Computer Science**
  This course gives students a comprehensive introduction to formal methods and their application in software specification and verification. It covers some fundamentals in formal methods, including set theory, functions, finite state machines, predicate and temporal logics, and model checking. The course will give students examples of real-world application of these formal techniques.

- **Master Thesis**
  This module enables students to transfer their skills and knowledge to research and carry out more complex tasks related to their master thesis. The module is designed to be fully practical and students to acquire the necessary knowledge and skills to approach writing the thesis. The module has unique return result-to enable students to write the master thesis with minimal difficulties, and with maximum efficiency. The course aims to improve research techniques and style of writing the paper, taking into account the prevention of the usage of illegal means, such as plagiarism and infringement of copyright, which are prohibited by the Statute of SEEU.

Elective courses

- **Programming in Java**
  Aims of the course program: To provide students regarding Java programming language with a deep, critical and systematic understanding of the principles and techniques for programming effective software applications. This course introduces fundamental structures and object-oriented programming concepts and techniques, using Java, and is intended for all who plan to use computer programming in their studies and careers.

- **Programming in .NET**
  This course introduces students to key concepts, real-world applications, and latest features of C# and .NET with hands-on exercises using Visual Studio. They will learn object-oriented programming core concepts, writing, testing, and debugging functions, implementing interfaces, and inheriting classes. The course will cover the .NET APIs for performing tasks like managing and querying data, monitoring and improving performance. At the end of the course, the students will be able to build and deploy cross-platform apps, such as websites and services using ASP.NET Core.

- **Cryptography**
  Introduces students to the compelling and evolving field of cryptography. In an age of viruses and hackers, electronic eavesdropping, and electronic fraud on a global scale, security is paramount. The purpose of this course is to provide a practical survey of both the principles and practice of cryptography. The first part of the course explores the basic

issues to be addressed by a security capability and provides a tutorial and survey of cryptography and security technology. The latter part of the cour deals with the practice of network security, covering practical applications that have been implemented and are in use to provide network security.

- **Programming in Python**
  The aim of this course is to introduce core Python programming basics, including data types, control structures, algorithm development, program design with functions and the fundamental principles of Object-Oriented Programming. In this course students will solve problems, explore real-world software development challenges and create practical and contemporary applications using web development frameworks.

- **Mobile Applications Development**
  Course aims: 1. To facilitate students to understand android SDK 2. To help students to gain a basic understanding of Android application development 3. To inculcate working knowledge of Android Studio development tool

- **Game Programming**
  Course aims: • To study of basic game development principles both in 2D and 3D Worlds • To ensure that students will know how to create and use various games objects • To ensure that students will understand user interaction • Study of game data structures and game physics • Learn about programming and creating detailed code for game projects • Basic artificial intelligence concepts

- **Parallel Processing**
  This course is intended for students interested in the efficient use of modern parallel systems ranging from multi-core processors to large-scale distributed memory clusters. The course covers theoretical principles of parallel computing as well as different parallel programming techniques. It begins with a survey of common parallel architectures and types of parallelism and follows with an overview of formal approaches to assess scalability and efficiency of parallel algorithms and their implementations. In the second part, the course focus is on selected parallel programming techniques and APIs, including shared address space, many-core accelerators, distributed memory clusters and big data analytics platforms. Each component of the course involves solving practical problems on a corresponding parallel architecture.

- **E-commerce**
  - Understanding and applying the concepts of electronic commerce, electronic business. - Recognition of business needs for adaptation to constant and continuous changes in the environment, and recognition of the importance of incorporating information technology into the most important business processes, improving their current operational efficiency to transform it into a competitive advantage. - To develop strategic, administrative, and operational planning for new businesses, or to improve existing ones with their technologies. - Develop knowledge about the basics of E-Commerce, which are made possible by new Information Technologies - They recognize the need for the organization to continuously adapt to the changes occurring in the current business atmosphere. - Discover opportunities in the environment so that you can apply them in valid innovations and do business. - Analyse business to identify internal and external factors that can be modified to be able to move to an electronic business model. - Develop strategic, administrative, and operational planning for a new, or already existing business by establishing strategies that use information technology in the most important business processes, in order to improve their current operation and turn it into a competitive advantage. - Develop an analytical and technical foundation to understand the unpredictable world of e-commerce, by sharing three domains: o Economics: business plan, electronic banking and money, marketing and advertising, customer relationship management o Sociology: secrecy, protection of intellectual property, laws and regulatory initiatives o Technology: Internet infrastructure, network security, web services, mobile commerce network security, services, mobile commerce

- **Computer Network Management (After Comp. Networks)**
  In this course students will study the principles and practice of systems administration and management, analysing and designing networks in a real lab environment. Students will use cloud servers and virtualized machines to explore the efficiency and security of your systems and get insights into the practices of industry companies like Cisco. Coursework includes design, installation, configuration and management of local- and wide-area network hardware and software.

- **NoSQL Databases**
  The course is a continue with extension of the knowledge in field of databases. The focus is addressed in NoSQL databases and help the student to complete its knowledge puzzle with the various database technologies. It starts with some concepts, principles, and taxonomies in field on NoSQL databases and continue with NoSQL database technologies of different types. The course covers: the principles behind the NoSQL databases, modern distributed

database theory, indexing and MapReduce programming model; architectures and common features of the main types of NoSQL databases (key-value stores, document databases, column-family stores, graph databases); explains of selected NoSQL database systems including practical experience; and other topics related to NoSQL databases. At the end of this course, students should be able to: • Understand NoSQL databases and technologies. • Understand distributed database systems and theory, • Understand indexes, MapReduce programming model, • Understand main types of NoSQL databases based on key-value stores, document stores, column-family stores and graph stores, and • Understand the difference between relational and NoSQL databases and important of use.

- **Mobile and Wireless Networks**
  The goal of the course is to provide students with fundamental knowledge into core concepts of the latest and next generation mobile and wireless networks. Throughout the course, students will be exposed to theoretical and practical aspects regarding the architecture and applications of Cellular, LTE, and 4G/5G systems. In addition, basic concepts of Wireless LAN (WLAN), sensor networks (IoT), Mobile Peer-to-Peer (MP2P), and emerging opportunistically connected mobile/vehicular networks (MANET and VANET), will be explored.

- **IT Professional Ethics**
  This course provides a comprehensive overview of the current ethical issues we face in the use of information technology (IT). It examines an array of long-standing and emerging issues facing IT users ranging from free speech, privacy, intellectual property, hacking, and the digital divide, to ethics in social networking and online communities. The course discusses the ethical dilemmas and responsibilities of IT users, and promotes the critical examination and responsible use of IT.

- **Digital Logic Design and Simulation**
  This course provides students with a comprehensive overview of the fundamental concepts of classical digital design and demonstrates how digital circuits are designed and analysed today. The aim is to introduce students to the modern digital hardware hierarchy and enlighten them with the most up-to-date computer hardware design methodologies. Also, the course content gives students a basic idea of how to design and simulate logic circuits and practically implement such circuits.

- **Numerical Methods**
  This module is designed such that it can provide students with the basic concepts and methods from numerical computing. The primary intent is to provide students with a sound introduction to the numerical methods. They have a big application in solving different problems which can be solved just by using the computers, therefore solving numerical problems will help students not just to apply them in different other areas, but simply it will help them to become better computer scientists. After e brief look at the ways the numbers are placed and manipulated in computers we will deal with fundamental computational problems, such are solving the equations, system of equations followed by an approximation theory. We will deal with the accuracy of numerical solutions and also the aim is to evaluate the functions, numerical differentiation and integration.

- **Internet of Things**
  The goal of the course is to provide students with fundamental knowledge into core concepts of the Internet of Things. Throughout the course, students will be exposed to theoretical and practical aspects regarding the architecture and applications of sensor networks and 4G/5G systems. Students will be able to use learned concepts through analysis of architectures and computer communication technologies for wireless Internet applications in the most diverse domains such as: smart environments, industrial and home networks of devices, as well as application in sensor and actuator networks.

- **Introduction to Artificial Intelligence**
  Introduction to the basics of artificial intelligence, intelligent agents, techniques for presenting knowledge and intelligent search and decision-making, game theory, formal logic, probability, and logical reasoning systems, learning by observation, training of neurons and learning stimulation. Also, students will be familiar with the basic concepts of LISP.

- **Cybersecurity**
  In Cybersecurity, introduces the technology, operational procedures, and management practices needed for successful cybersecurity. Makes extensive use of standards and best practices documents that are often used to guide or mandate cybersecurity implementation. Going beyond these, he offers in-depth tutorials on the “how” of implementation, integrated into a unified framework and realistic plan of action. Each chapter contains a clear technical overview, as well as a detailed discussion of action items and appropriate policies. Cybersecurity aligns with the comprehensive Information Security Forum document “The Standard of Good Practice for Information

Security," extending ISF's work with extensive insights from ISO, NIST, COBIT, other official standards and guidelines, and modern professional, academic, and industry literature.

- **Introduction to Information Systems**
  Course aims: 1. To learn the basic concepts and the terminology of Information Systems a. Basic Information Systems concepts: hardware, software, networks b. E-World: e-business and e-commerce c. Developing Processes 2. To learn about the Information Systems and technologies that improve business values and various processes inside organizations. 3. Applying IS concepts with various managing disciplines, during analysis, interpretation, assessments and decisions. 4. Understand the process of redesigning organizations using information systems. 5. Describe the role of information systems in decision making. 6. Examine information security, ethical, and social issues. 7. Be familiar with the Internet, electronic commerce, and e-business. 8. Prepare students to work on small scale projects, individual or group work, who by nature could fall into these categories: case studies, scientific research project, development projects or internship projects.

- **Business Analytics**
  Business Analytics teaches the fundamental concepts of modern business analytics and provides vital tools for understanding how data analysis works in today's organizations. The course takes a comprehensive approach, examining business analysis from both descriptive and predictive perspectives. Students learn how to apply fundamental principles, communicate with analytics professionals, and effectively use and interpret analytics models to make better business decisions. As tools, among others, Excel will be used, strengthening the students' skills in the program and the basic understanding of the basic concepts. Additionally, Analytic Solver as well as commercial data-mining tools will be used so that students are prepared to use these same tools when they graduate.

- **Compilers**
  The aim of this course is to offer knowledge and related skills in the area of programming languages compiler implementation including lexical analysis, syntax analysis, parsing, syntax driven translation, abstract syntax trees, types and type check, intermediate languages, dataflow analysis, program optimization and code generation.

- **Information Theory**
  This course attempts to be a comprehensive overview of the field with focus on applications and ways in which communication and representation of information manifest in various areas. In this course, students will learn the basic concepts of information theory and some of their primary applications, including data compression and storage, wired and wireless communications, statistical inference and machine learning, to name a few.

- **Human - Computer Interaction**
  This course aims to enable students with knowledge of the theory and practice in software development related to the communication between humans and computers, with the goal of creating usable application interfaces. The course deals with the psycho-motor aspects that influence the way people communicate with machines. Through concrete examples of user interfaces, students should understand the principles and be able to apply them while designing their applications.

- **High Performance Computing**
  The course stresses the need for and the design of high-performance computing (HPC) systems. It provides a solid foundation in High Performance Computing (HPC) and studies the fundamental techniques for developing HPC applications. The course focuses also on commonly used HPC platforms, the methods for measuring, assessing, and analysing the performance of HPC applications, and the role of administration, workload and resource management in an HPC management software. The students will be introduced also to the issues related to the use of HPC techniques in solving different problems.

- **Neural Networks and Deep Learning**
  The course focuses on the theory, structure and algorithms of neural networks and deep learning. The theory and algorithms of neural networks are particularly important for understanding deep learning concepts, so these this course offers important design concepts of neural architectures in different applications. And it covers the theory and algorithms of deep learning as well, providing detailed discussions of the relationships of neural networks with traditional machine learning algorithms. This theory is linked and described with real world practical applications.

- **Natural Language Processing**
  This course helps students to explore into the exciting world of Natural Language Processing (NLP) giving an overview of major topics in the field. Students will understand how computers work with human language, learn techniques and libraries for data analysis and create natural language processing tools as well. Interactive

demonstrations and hands-on analysis of real-world applications will focus on a range of tasks: language translation, text classification, text clustering, sentiment analysis, speech recognition, summarization etc.

- **Software Defined Networks**
  This course introduces software defined networking, an emerging paradigm in computer networking that allows a logically centralized software program to control the behaviour of an entire network. The course will teach the concepts and techniques for Software Defined Networking (SDN), including an overview of available controllers, switches, and tools. More specifically, the course will cover a review of basic networking concepts, motivation and use cases for SDN, general SDN architecture and building blocks, Network Functions Virtualization (NFV), SDN protocols, and existing SDN applications.

- **Web Services and Applications**
  This course introduces students to software architectures designed to enable computer programs to communicate over a network using open standard Internet protocols. They will learn how to design and develop SOAP and RESTful web services using various frameworks and tools. Moreover, they will learn about advanced concepts like security, versioning, error handling and serverless APIs. After completing the course, students will have enough knowledge to design, develop and deploy highly adaptable and scalable real-world applications using services.